Research Note

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
INTERMOUNTAIN FOREST & RANGE EXPERIMENT STATION
OGDEN UTAH

U.S. Forest Service
Research Note INT-2 1963

LABORATORY METHODS FOR DETERMINING THE DOWNWARD MOVEMENT OF SEED ON ROAD FILLS

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ABSTRACT

Attempts to seed fill slopes of newly constructed roads often fail because seed is not retained on the hardened, compacted, crusted surfaces of the fills. Model "road fill slopes" were set up in the laboratory to test several soil surface treatments for arresting downward movement of broadcast seed. Results of this study suggest that seeding upon a mulch already in place, "pockmarking" the soil surface, wetting the soil surface, and spreading wetted seed, reduce seed dispersion.

INTRODUCTION

Road construction on soils derived from the granite batholith in central Idaho usually commences as soon as snow melts in the spring and continues until the following late fall or early winter, when snow stops the operation. After road construction, raw exposed road fill of granitic origin undergoes numerous physical changes. For instance, its surface usually crusts over and becomes hard and compacted. By September or October, when the weather becomes favorable for seeding for erosion control, seed broadcast on the fill literally bounce off the crusted surface and onto the undisturbed forest floor below. Consequently, very few seed may be left on the road fill to germinate and produce the desired protective cover.

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This phenomenon of seed displacement may be one cause for the erratic establishment of grass and other vegetation on mountain road fill slopes. To study this particular facet of the problem, model road fill slopes were set up in the laboratory for testing various methods for arresting the downward movement of broadcast seed.

METHODS

Four wooden boxes, each 2 by 2 feet in size, were filled with thoroughly mixed, fresh road fill of granitic origin and moved to the laboratory. Each box was then elevated at one end to simulate a road fill having a 70-percent slope. A uniform crusted surface was obtained by smoothing and spraying the fill material with water, and then air-drying for several days prior to each treatment.

Five different soil conditions were tested for ability to retain seed: the soil surface crusted and dry (control), the surface moistened, the surface "pockmarked" with holes at a density of four per square foot (fig. 1), and the surface covered with two kinds of mulch--unchopped timothy hay and narrow-mesh paper netting.[2] Additional combinations and variations of these treatments were also tested; e.g., the soil surface was moistened after being covered with paper netting (fig. 2A); and moistening the seed instead of the soil prior to seeding. The test of seed retention was replicated twice on the four boxes, for a total of eight observations per simulated fill slope condition.

Figure 1.--Fill slope treatment of surface holes on dry, crusted surfaces.

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[2] The authors are indebted to Bemis Bros. Bag Co., St. Louis, Mo., for furnishing the material for experimental testing.

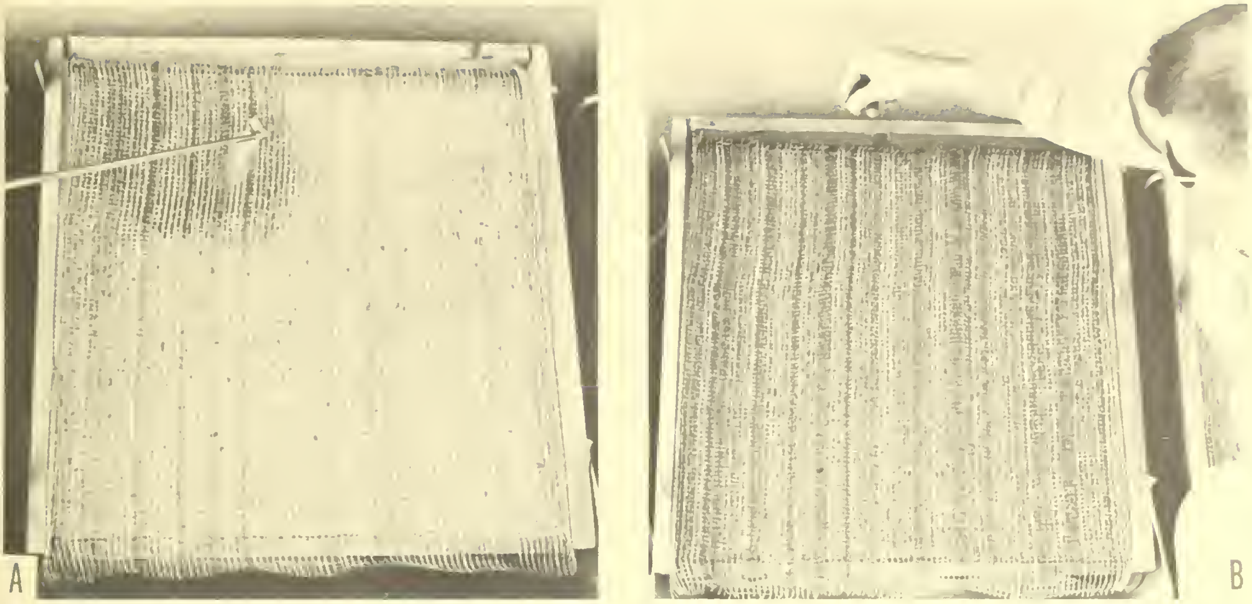

Figure 2.--Fill slope treatment of mulching with paper netting: A, sprayed with water; B, applying dry seed.

For each test of seed retention on the simulated fill slopes, a mixture of 100 seeds of each of four adaptable species--cereal rye (Secale cereale), yellow sweetclover (Melilotus officinalis), intermediate wheatgrass (Agropyron intermedium), and smooth bromegrass (Bromus inermis)--was broadcast on each box. To maintain uniformity, the seeds were dropped by hand across the top of the box, 6 inches above the treated surface and 2 to 3 inches below the top edge of the box (fig. 2B).

Displaced or nonretained seeds (those that fell over the bottom lip of the box) were trapped in kraft paper troughs tacked below the lip. Seeds of each species caught in the trough were subtracted from 100 to give the number of seeds retained on the fill slope surface in a box. Seeds retained then became the index for judging the relative efficiency of fill slope surface treatments.

As a sidelight, counts were made of seeds applied on unchopped timothy hay and chopped hay with asphalt binder to determine the initial number of seeds trapped within the hay mulch. These results are discussed later under effect of mulching.

The data on seed retention were examined statistically by an analysis of variance with the inclusion of Duncan's multiple range test[3] for discriminating between means.

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[3] Duncan, D. B. Multiple range and multiple F tests. Biometrics 11: 1-42. 1955.

VARIATIONS IN SEED RETENTION

Analysis of the data confirmed the observation that fewer cereal rye and yellow sweetclover seeds were retained on the simulated road fills than were seeds of intermediate wheatgrass and smooth bromegrass, irrespective of soil surface treatment.

The physical characteristics of both types of seed account for these differences. Cereal rye and yellow sweetclover seed are very firm, generally rounded in shape, free of lemma or pod, and relatively short, as shown in the tabulation below. These streamlined, hard seeds readily bounce off steep, compacted surfaces. On the other hand, the seeds of intermediate wheatgrass and smooth bromegrass have greater overall length because they usually remain attached to a lemma (see tabulation below). The lemma has flat surfaces and irregular edges that reduce bouncing or sliding.

Seed	Length[1] (mm)
Cereal rye	5.8
Yellow sweetclover	2.0
Intermediate wheatgrass	8.5
Smooth bromegrass	7.7

[1] Average of 10 seeds or seed-filled lemmas of each species.

On the basis of these results, the seed retention data were separated and analyzed as two distinct statistical populations.

SEED RETENTION ON DRY, CRUSTED SOIL SURFACES

Hard, rounded seed.--Less than one-fourth of the hard, rounded seed of cereal rye and yellow sweetclover were retained in soil boxes under the control surface condition of dry, crusted soil (table 1). Seed moved with great ease either by bouncing, sliding, or rolling on the crusted surfaces that were relatively free of small rock protrusions and miniature depressions.

Elongated, flat seed.--Almost $3\frac{1}{2}$ times as many elongated, flat seed of intermediate wheatgrass and smooth bromegrass were retained as were the rounded seed.

Table 1.--Effect of different fill slope surface conditions and seed treatments on the downward movement of hard, rounded seed and elongated, flat seed

Fill slope and seed treatments	Seed retained--mean[1]		Statistical significance[2]	
	Hard, rounded	Elongated, flat	Hard, rounded	Elongated, flat
	- - - - - - Percent - - - - -			
Dry soil, unchopped timothy hay, dry seed	99.9	100.0	a	a
Wet soil surface holes, wet paper netting, dry seed	96.8	99.4	ab	ab
Wet soil, wet paper netting, dry seed	96.6	99.4	ab	ab
Dry soil, dry paper netting, dry seed	92.8	98.4	bc	abc
Dry soil, surface holes, dry seed	91.5	99.4	c	ab
Wet soil, surface holes, dry seed	74.2	97.1	d	bc
Dry soil, wet seed	72.9	93.1	d	d
Wet soil, dry seed	43.0	96.3	e	c
Dry soil, dry seed (control)	23.6	80.9	f	e

[1] Out of a possible 200 seeds, replicated eight times.

[2] Means followed by letter "a" are significantly different from those means not having "a"; those followed by "b" are significantly different from those not having "b," etc.

SEED RETENTION AFTER MODIFYING SOIL AND SEED SURFACES

Hard, rounded seed.--By softening the crusted fill slope surfaces with water, the number of seeds retained over the control increased almost twofold; or by applying wet seed (similar to a Hydro-seeder operation), the advantage was nearly threefold (table 1).

Pockmarking the fill slope surfaces with the end of a shovel handle further improved the retention capabilities by creating small depressions or seed traps. Interestingly, the dry soil condition with surface holes, which resulted in 91.5 percent seed retention, was significantly better than wet soil with surface holes, which retained only 74.2 percent. This unexpected increase under dry soil conditions is attributed to the shattering effect of the holes in the surrounding soil which left cracks in the crust and raised lumps of soil that caused seed to lodge (fig. 1). On the wet, softened soil surfaces, the holes were smooth punctures that did not create rough interspaces for trapping additional seed.

Elongated, flat seed.--An increase was observed in the number of seeds retained in nearly the same order of the superimposed treatments (table 1). Each modification of the soil surface increased seed retention to well over 90 percent.

EFFECTS OF MULCHING ON RETENTION

Hard, rounded seed.--A single covering of paper netting on the dry soil (control) surfaces increased retention almost fourfold, denoting the pronounced effect that single strands of woven paper have in trapping falling seed. The additional slope treatments of surface holes and wetting further improved the mean percentages of seed retention, but the differences are not significant (table 1).

A slope surface covering of unchopped timothy hay mulch was the most effective method of checking seed displacement. Only two of the 1,600 hard, rounded seed broadcast on the mulch were displaced; movement of seed downslope under this surface treatment is negligible.

Tests conducted separately from the main study showed that broadcast seeds do not initially penetrate the unchopped hay mulch 100 percent. As expected, the amount of penetration varies to some degree with species. Seeds of smooth bromegrass, cereal rye, and intermediate wheatgrass had fall-through percentages of 41.3, 45.3, and 46.7 percent, respectively. Seeds of yellow sweetclover had the highest fall-through percentage, 63.6 percent, which is significantly greater than that for the other species (table 2).

A similar relation existed for broadcast seeds on chopped hay mulch with asphalt binder, except that the overall percentages were considerably less (table 2). Seeds readily sifted through the asphalt-free hay; contrariwise, they easily adhered to the tacky asphalt binder in the chopped hay.

Table 2.--Initial penetration of broadcast seeds, by species, on unchopped timothy hay mulch and chopped timothy hay mulch-asphalt binder

Species	Seed penetration--mean [1]		Statistical significance [2]
	Unchopped hay	Chopped hay--asphalt binder	
	Percent		
Yellow sweetclover	63.6	52.6	a
Intermediate wheatgrass	46.7	16.1	b
Cereal rye	45.3	23.1	b
Smooth bromegrass	41.3	18.1	b

[1] Out of a possible 100 seeds, replicated eight times.

[2] Mean followed by letter "a" is significantly different from those means not having "a"; and those followed by "b" are significantly different from the mean not having "b."

Elongated, flat seed.--The unchopped timothy hay and paper mulches, including surface holes and wetting, were highly effective in retaining seed. A small, non-significant percentage of 1.6 separated the lowest and the highest retention by treatments of this group (table 1). The treatment with the highest retention percentage was unchopped hay on dry soil.

APPLICATION OF LABORATORY RESULTS TO FIELD CONDITIONS

Several treatments tested under laboratory conditions were found to reduce the downward movement of broadcast seeds on the surface of a simulated road fill. The laboratory data, expressed in relative numbers of seeds retained, should not be interpreted literally as to what might happen on the surface of a road fill under field conditions. However, they are probably fair indices for judging the merits of each treatment.

Some general comments and recommendations follow:

1. Because of inherent physical characteristics, hard, rounded seed of cereal rye and yellow sweetclover are more apt to roll and slide downhill on road fills than the elongated, flat seed of intermediate wheatgrass and smooth bromegrass.

2. Applying seed to a road fill pockmarked with shallow holes or to a wet road fill or applying wet seeds on a dry surface will enhance their retention after they fall. Treatment of holes on dry, crusted surfaces is superior to that on wet, soft road fills. The relative importance of these three treatments is more significant if hard, rounded seed are included in the mixture.

   Added benefit to surface holes as seed traps comes from the natural covering of seed with slough material, thus protecting the seed from wind, promoting faster germination, and perhaps improving the chances for survival.

3. Seeding upon a paper mulch or after an unchopped hay mulch is applied proved to be the best methods tested for reducing the downhill movement of seed. However, substantial numbers of seeds will be trapped on the leaves and stems of the hay before they reach the soil surface. How many of these seeds will remain suspended in the mulch under the influence of wind, rain, and snow is problematical.

If the hay is chopped and mixed with asphalt binder, considerably more seeds are trapped and readily held by the tacky binder. Under these circumstances the standard procedure of applying wet seed with a Hydro-seeder machine prior to mulching with chopped hay-asphalt binder is more desirable. As the results of the study imply, the Hydro-seeder more effectively places seed in contact with the ground surface than the application of dry seed after this form of mulch is in place.